

Activity Levels and Outcomes of a Standalone Regional Paediatric High Dependency Unit

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Abstract

Aim

The Paediatric High Dependency Unit (PHDU) at University Hospital Limerick (UHL) operates as the only standalone unit outside of Dublin centres. The aim of this study was to describe a regional PHDU population, compare outcomes with international standards (PICANet) and ensure adequate clinical governance.

Methods

This is a retrospective analysis of 126 admission records from January - December 2019.

Results

There were 126 admissions to PHDU in 2019, of which respiratory (n=81, 64.3%) and neurological (n=23, 18.3%) subgroups represented the largest populations. Median length of stay was two days with mean age of admission 3.97 ± 4.5 years and slightly more male admissions (56%). Of the total, 65% required oxygen, 32.1% needed CPAP directly and 38% commenced high-flow, of whom 29% transitioned to CPAP. Transfer for tertiary care was required in 10.3%, of whom 7.9% needed PICU.

Conclusion

The data show UHL PHDU to have a patient population reflecting international trends as well as producing satisfactory patient outcomes. With a low rate of transfer for tertiary care and given that 15 other paediatric units exist in the Republic of Ireland outside Dublin, development of regional PHDU capacity would provide great opportunity to decrease strain on PICU bed capacity, particularly during busy Winter months.

Introduction

The Paediatric High Dependency Unit (PHDU) at University Hospital Limerick (UHL) has been operational since 2010 and is currently the only fully operational PHDU situated outside the Dublin tertiary paediatric centres¹. This contrasts with similar units in the United Kingdom (UK) where Level two Paediatric Critical Care Units (PCCU) are more frequently functional in acute hospitals providing inpatient care to children^{2,3}. Some regions, like the Southwest of England, have a PHDU in every paediatric unit outside the tertiary centre³.

There exists considerable variation in PHDU capacity and the resultant inequity nationally as to how a critically ill child who requires HDU level care is managed. In one region a child could be cared for locally but could require intubation, ventilation, and transfer to a paediatric intensive care unit (PICU) in another region, adding complexity, risk and cost which is potentially avoidable.

The PHDU at UHL has operational capacity for two inpatients with facilities to provide level two PCC⁴. Nursing complements are allocated from a trained pool of PHDU nurses from the general paediatric wards when the PHDU is in operation. While the unit has four bed bays (including one for isolation), the available nursing whole time equivalent (WTE) can only safely operate two beds. The area served covers three counties: Limerick, Clare, and North Tipperary, with a total paediatric population of 98,106 children under the age of 16⁵ and a regional birth rate of 4144 in 2019⁶.

From this unique standpoint, we aim to categorise the patient demographic requiring PHDU admission and assess this with national PHDU (all adjacent to PICUs) and international standards with specific reference to the Paediatric Intensive Care Audit Network (PICANet), an audit database recording details of the treatment and outcomes of all critically ill children in PICUs across the UK and Republic of Ireland. Such comparative analyses have not previously been conducted and are essential to characterise the level of activity being undertaken in our regional PHDU.

Methods

A structured proforma was used to retrospectively collect information from the PHDU admission book, transfer book, patient files and digital records (i.e., iLab, e-discharge records, NIMIS) for all patients admitted to the PHDU between 01/01/2019 and 31/12/2019. The data variables analysed were selected based on the PICANet Data Collection Form, where specific data values were analysed based on the level of care provided.

Data were anonymised and collated using a standardized excel data collection tool, in line with GDPR standards⁷.

Statistical analysis was conducted using descriptive tools and proportions. These data were submitted for inclusion in the inaugural National Irish Paediatric Critical Care Audit report. Research ethics approval was obtained from the UL hospital Research Ethics Committee.

Results

During the study period, there were 126 admissions to PHDU, encompassing a total of 256 bed days.

Of these admissions, 121 (96%) were admitted from another care area in the same hospital, two (1.6%) from another hospital and three (2.4%) from home. With reference to the care areas: 84 (66.7%) were admitted from the Emergency Department (ED), 33 (26.2%) from the general paediatric wards, 6 (4.8%) post-operatively and three (2.4%) represented direct admissions from home (e.g. patients with tracheostomy).

At discharge 124 (98.4%) patients were alive and two (1.6%) had died. Of the surviving patients 13 (10.5%) were discharged directly home, 98 (79.0%) to general paediatric wards and 13 (10.5%) were transferred to a tertiary centre – 10 (76.9%) to PICU and 3 (23.1%) to a general ward in a tertiary paediatric centre. At 30 days post-discharge 124 (98.4%) were still alive.

The distribution of age and gender are presented in table 1. The mean age of admission was 3.97 ± 4.5 years, with two years being median age of admission. The youngest patient was two weeks old and oldest 17 years old.

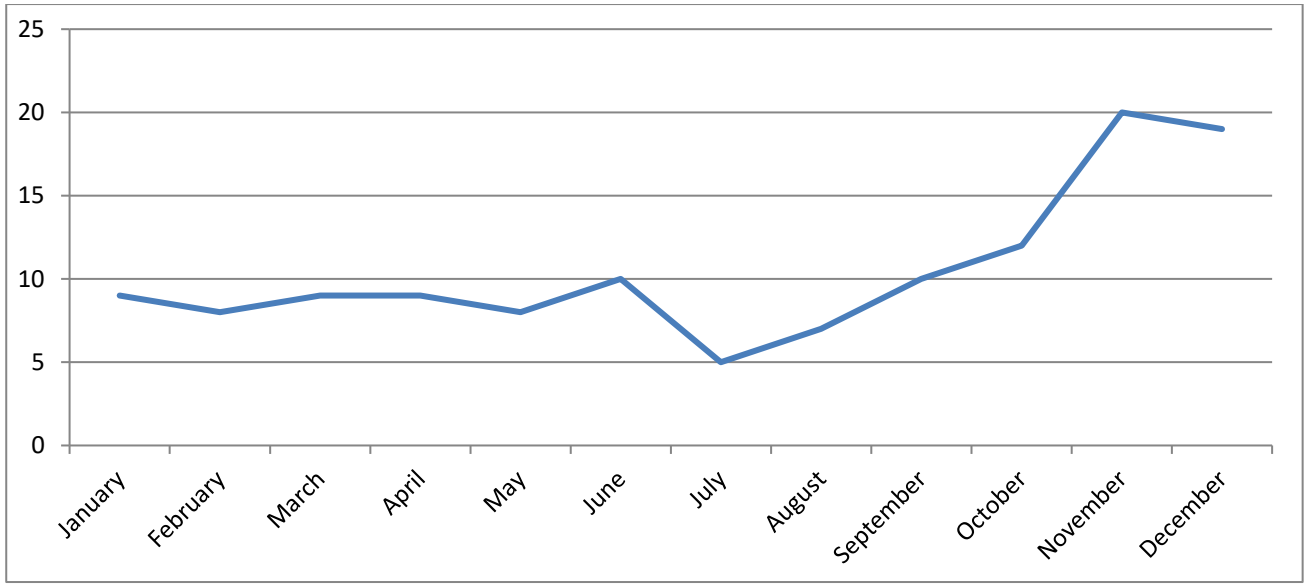
The median length of stay (LOS) in the PHDU was 2.03, with less than a day being the shortest LOS and 9 days being the longest LOS. Cost estimations in 2019 for overnight stay in PHDU were reported as €1466 per night, totaling an annual cost of €375,296.

Table 1: Age Group and Gender Distribution of Patients admitted to PHDU, University Hospital Limerick, Ireland.

Age	Female		Male		Total	
	n	%	n	%	n	%
<1	20	15.87	22	17.46	42	33.33
1 to 5	24	19.05	24	19.05	48	38.10
>=5	11	8.73	25	19.84	36	28.57
Total	55	43.65	71	56.35	126	100

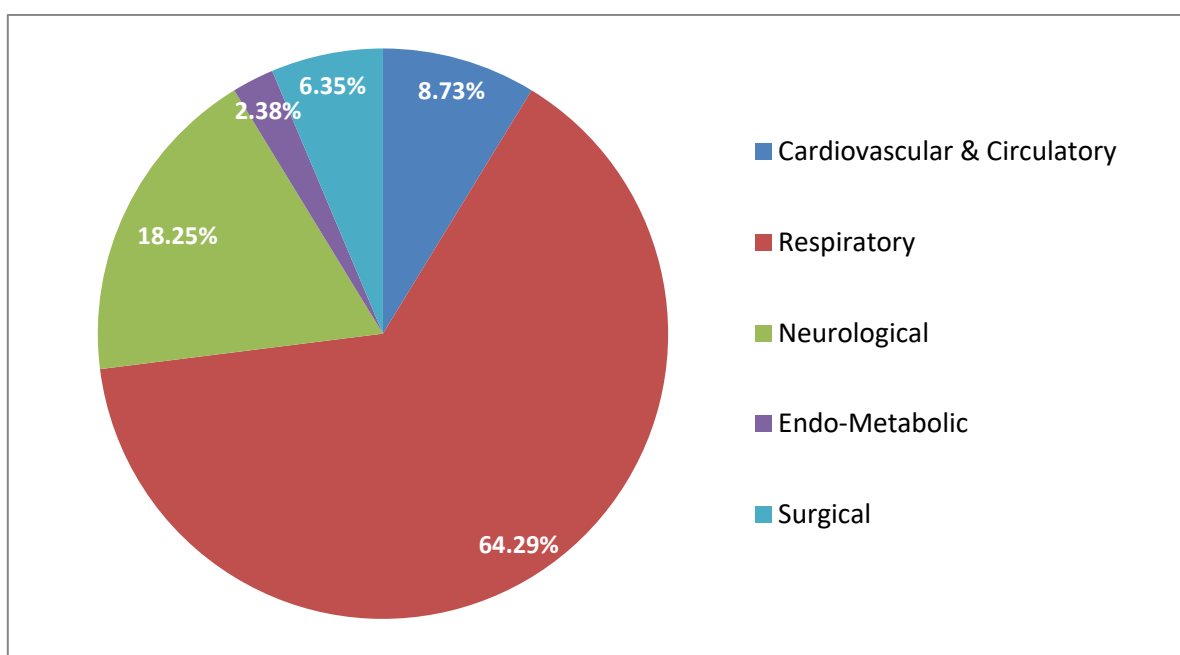
The seasonal trend is demonstrated in Fig 1, with 78 patients (61.9%) admitted in the colder months (September to February) and 48 (38.1%) in the warmer months (March to August).

Figure 1: Line Chart Representing Seasonal Trend of PHDU Admissions, Limerick.



Admissions were classified into subgroups based on clinical system affected (Fig 2). Just under two thirds (n=81, 64.3%) were admitted for respiratory support, while the second largest cohort of patients (n=23, 18.3%) were admitted for neurological support, followed by cardiovascular and circulatory (n=11, 8.7%), surgical (n=8, 6.4%) and lastly endocrine-metabolic (n=3, 2.4%).

Figure 2: Pie Chart Representing Systems Requiring Support in PHDU.



Of those admitted for respiratory support, 34 (42.0%) were diagnosed with bronchiolitis, 26 (32.1%) were diagnosed as lower respiratory tract infection (LRTI) and five (6.2%) were diagnosed with brief resolved unexplained event (BRUE). Croup and asthma admissions were equal at four patients (4.9%), as were near drowning, inhalation of a foreign body and respiratory depression at one patient (1.3%). Two patients (2.5%) were admitted for tracheostomy support. In terms of support received, all patients in the respiratory subgroup were receiving supplemental oxygen in the PHDU. For non-invasive respiratory support, 31 patients (38.3%) required high flow nasal cannula (HFNC) and 26 (32.1%) required continuous positive airway pressure (CPAP). Of the patients who were on HFNC, 9 (29.0%) were transitioned to CPAP. Of those treated with CPAP, 17 (65.4%) were admitted on CPAP.

Of those admitted for neurological support, 18 (78.2%) were for a seizure disorder (status epilepticus), two (8.7%) for encephalitis, while head injury, acute dystonia and poisoning and overdose each represented one patient (4.4%).

Patients admitted for cardiovascular and circulatory support consisted of four (36.4%) for sepsis, two (18.2%) for cardiomyopathy and poisoning and overdose, and one patient (9.1%) for supra-ventricular tachycardia (SVT), malaria and haemolytic uremic syndrome (HUS) respectively.

Breakdown of surgical patients consisted of four (50%) post-appendectomy, two (25%) post-tonsillectomy, and one (12.5%) with pyloric stenosis and splenic laceration respectively.

The final group were admitted under the endocrine-metabolic category and were categorised as two admissions (67.7%) for diabetic ketoacidosis (DKA) and one (33.3%) for Hurler's syndrome.

Of the 126 patients, 13 (10.3%) were transferred to a tertiary service. Ten (7.9%) were transferred to PICU and three (2.4%) to a tertiary care ward. Of all the patients transferred to PICU, 9 (90%) were in the respiratory subgroup, while the remaining one patient (10%) was in the cardiovascular subgroup.

The two deaths in PHDU represent patients who had advanced care plans in place on admission to the unit, where ceilings of care had been previously established.

Discussion

High dependency care (HDC) is described as a requirement for close observation, monitoring or intervention that cannot be delivered in a normal ward environment, but at the same time does not require admission to an intensive care unit (ICU)⁸. At present in the Republic of Ireland, an unknown volume of HDC is being provided across a wide variety of settings and locations, often with little information about activity levels and patient outcomes⁹. A recent report from the UK reveals that hospitals without an onsite PICU continue to deliver high dependency level of care, without a true national estimate of this activity¹⁰.

Most of our patients were admitted as unplanned emergency admissions from ED, where the largest proportion consisted of males in the under-five age group. This would be representative of the typical PHDU population and is reflective of international PICU admissions for 2017 – 2019 recorded in the PICANet annual audit¹¹. We noticed a sharp increase in total admissions over the winter months, when more than two-thirds were admitted – correlating with the predictable rise in incidence of viral respiratory tract infections. Of the respiratory subgroup, 55 patients (67.9%) were admitted between September and February, compared to 26 (32.1%) admissions between March and August.

In 2019 our PHDU was operational for a total of 265 bed days, at an equivalent estimated total cost to the hospital of €375,296. Currently, there is no ring-fenced additional funding for PHDU activity delivered outside PICU/Tertiary services, thus providing a disincentive for peripheral hospitals to undertake HDU activity⁹. Furthermore, within a ward environment with limited staff resources such as a general paediatric ward, diversion of allocated staff to deliver PHDU level of care can result in less-than-optimal care for other patients. Several audits conducted in the National Health Service (NHS) in England have confirmed that children admitted to PHDU consume significantly more staff resources than general ward patients, prompting the need for additional funding to allow for high quality PHDU care whilst maintaining the same level of care for general ward patients⁸. Furthermore, extra funding would be required to train nurses and allied health care workers (HCW) in order to effectively manage PHDU patients. Our own local unit has established a PHDU training programme to support ongoing learning and continued medical education to support a safe delivery of Level two PCC in the region.

In 2019 in Ireland there were a total of 1,465 admissions to PICU with admissions by transfer consisting of 449 patients (30.7%)¹¹. Transfers are ideally performed by the Irish Paediatric Acute Transport Service (IPATS), which is the national specialist retrieval team for the country. In 2019 transfers to PICU by IPATS constituted 100 patients (22.3%), while non-specialist transfers represented 175 patients (39%) and transfers by the neonatal team represented 164 patients (36.5%)¹¹. The central PICU teams contributed 8 transfers (1.8%) while two patients (0.04%) had an unspecified transfer¹¹. Non-specialist transfers are conducted by paediatric or anaesthesiology NCHDs or consultants from the regional service, further contributing to depletion of local resources generated by a patient requiring transfer. Provision of local PHDU care in more units and an expansion in IPATS operational capacity would ease the strain on already overburdened services.

Regarding primary diagnostic categories, the largest proportion was the respiratory group, representing nearly two-thirds of our admissions. The largest subgroup consisted of children admitted with bronchiolitis, followed by patients with LRTI. One third of these patients required nasal CPAP and with the median admission duration of 2.03 days, the average LOS for these patients was relatively short. The second largest primary diagnostic group were neurological, mainly consisting of care of patients in status epilepticus. Both cohorts represent typical unplanned emergency activity in any regional unit delivering care to paediatric patients. In units without a PHDU, it is likely that these children are either transferred out or cared for in less appropriate clinical settings such as on a general paediatric ward, or in an adult ICU.

The transfer rate for Level three care from our PHDU was 10%. Admissions to PICU in the Republic of Ireland by transfer in 2019 totalled 449 patients¹¹. Our centre contributed 10 of these patients. Since our PHDU opened in 2010 we have seen a decrease in transfers to tertiary care of 54%¹². Audits from Scotland and Yorkshire estimated that 8-12% of all paediatric admissions to hospital meet criteria for requirement of HDC^{3,13}. Given that 15 other paediatric units exist in the Republic of Ireland peripheral to Dublin, development of additional regional PHDU capacity would provide great opportunity to decrease strain on PICU bed capacity particularly during the Winter months, with improved potential for uninterrupted scheduled care e.g., paediatric cardiac surgery. Moreover, parents would be able to care for their sick children closer to home following the principles of family-centred care¹⁴.

Our study revealed that the paediatric population treated in our PHDU is representative of the typical PHDU population, with satisfactory outcomes and short length of stay. We provide positive evidence for the value of a regional PHDU, providing care to children close to home and therefore reducing stress, cost, and travel burden on families. The need for PHDU-specific funding remains a limiting factor nationally to optimise the local provision of Level two paediatric critical care, which has the potential to safely and significantly reduce pressure on Level three tertiary units, particularly during the busy winter season.

Declaration of Conflicts of Interest:

None declared.

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